

## BLUE-SKY MEASUREMENTS AT APIA, SAMOA

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Observations on the blueness of the sky have been regularly made at Apia, Samoa (13° 48' S., 171° 48' W.), South Pacific Ocean from January, 1927, to October, 1928. The intensity or depth of the blue was determined on a scale devised by F. Linke by a method recently described in this journal.<sup>1</sup> The deepest blue, ultramarine, is designated tint 12; the lightest, a bluish white tint, is 2. The data are of interest on account of being taken at sea level on an island where contamination of the air by smoke or fog does not occur. The island, which is covered with dense vegetation, has an area of 450 square miles. Apia lies not far from the center of the south-east trade wind belt in extreme oceanic surroundings, the total land area within 1,500 miles being less than 1 per cent.

The color of sky was observed, when possible, at 9 a. m. and 3:15 p. m. In 19 months the sky has been found to vary from lightest tint 4, occurring once, to deepest tint 10, occurring eleven times. Table 1 shows the annual variation in blueness of the sky.

TABLE 1.—Annual variation in blueness of sky at Apia, Samoa

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A. m. ....	7.0	7.4	7.3	7.0	7.6	6.8	8.0	7.8	7.8	7.9	7.5	7.3
P. m. ....	6.5	7.6	7.0	6.4	6.0	6.6	6.2	7.0	7.9	6.8	7.2	7.3

It is seen immediately that the sky is a deeper blue in the morning than in the afternoon, especially so during the trade-wind, or dry season, from May to September.

Dividing up the year into three seasons—wet, November to February; dry, May to August; and equinoctial, September, October, March, and April, the differences forenoon and afternoon are as follows:

	Mean	A. m.— p. m.
Dry .....	7.32	0.50
Equinoctial .....	7.11	.28
Wet .....	7.22	.15

<sup>1</sup> Linke, F. Mo. Wea. Review, June, 1928, 56:224.

There is obviously only a very slight seasonal change. The smallness of the a. m.—p. m value in the wet season is due to the frequency of the rain which produces constant humidity conditions throughout the day. In the dry season, the convection and vertical currents set up causes, both by the presence of slightly condensed water vapor and by the enlargement of salt particles, a whitening of the sky.

The blueness of the sky at any moment is closely related to the existing cloudiness and the visibility vide. (Table 2.) In the scale of cloudiness 10 is overcast and 1 the almost unchanging ring of cumulus cloud occurring in fine weather around the horizon at sea in the Tropics.

TABLE 2.—Variation of sky blue with cloudiness and visibility

Tint of blue .....	4	5	6	7	8	9	10
Number of observations .....	1	13	50	84	125	58	6
Mean cloudiness .....	6	5.7	5.0	3.9	2.3	1.9	1.8
Visibility .....	5	4.1	4.1	3.7	3.4	3.2	3.3

The visibility is measured according to an arbitrary scale from 1 to 6 in which visibility 6 represents seeing, such that light and dark area may be clearly distinguished on a mountain side 50 kilometers distant and, visibility 1 when an object 1 kilometer distant is just visible. All objects are viewed across water. Lighting effects were eliminated by having the objects in line and including only morning observations.

The presence of clouds is concomitant with the lighting up of the sky. This may arise either, as Linke suggests, from the hygroscopic enlargement of particles floating in the air or from the formation of thin clouds. The particles are doubtless largely of common salt formed by evaporation of sprays. These float principally in the lower stratum of the air so that their removal by rain increases both visibility and the depth of blueness of the sky.

## SEVENTEEN-YEAR RECORD OF SUN AND SKY RADIATION AT MADISON, WIS., APRIL, 1911, TO MARCH, 1928, INCLUSIVE

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**Introduction.**—Beginning with April, 1911, a continuous record of the intensity of sun and sky radiation has been obtained at Madison, Wis., through the medium of the Callendar bolometric sunshine recorder. The record has been made by receiver No. 9864. For a description of the instruments, their errors, reduction factor, and exposure, the reader is referred to Kimball & Miller (1).

**Radiation.**—Summaries of the hourly, daily, weekly, and annual intensities and extremes have been tabulated and are presented here. Curves of normal and maximum intensities, etc., have been prepared from the data. The intensity of solar rays incident at a point on the earth's surface is chiefly dependent on the elevation of the sun with respect to that point. The incoming rays are absorbed in proportion to the thickness of the atmosphere; i. e., the air mass,  $m$ , through which they must pass. The regular fluctuations of daily and annual radiation are the result of the revolution of the earth on its axis, and the change in the sun's declination and

distance effected by the earth's revolution in its orbit around the sun. The irregular variations are due to the effect of the weather and the change in the quality of the transmitting atmosphere.

**Transparency.**—The transparency of clear air is dependent upon three factors—the depletion of radiation due to the molecular scattering and absorption by dry air; by wet haze, or water vapor; and by dry haze, or dust. The last two vary greatly from a maximum in the warm season to a minimum in winter, as shown by Table 1. Transparency is here represented by means of the atmospheric transmission coefficient,  $a$ , computed from

the equation,  $a^m = \frac{Q'}{Q_0}$ , where  $m$  equals air mass,  $Q'$  the

value of the radiation intensity corresponding to  $m$ , reduced to mean solar distance, and  $Q_0$  the value of the solar constant, here assumed to be 1.94.